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THE *IXODES RASUS* GROUP OF AFRICAN TICKS WITH
DESCRIPTIONS OF FOUR NEW SPECIES
(IXODOIDEA, IXODIDAE)

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No. 9 — *The Ixodes rasus Group of African Ticks with
Descriptions of Four New Species (Ixodoidea, Ixodidae)*

BY DON R. ARTHUR¹ AND COLIN BURROW

INTRODUCTION

Hitherto the African ticks of the genus *Ixodes* which possess closed circular anal grooves have been incompletely investigated and all such ticks have been referred to the species *Ixodes rasus* Neumann 1899. This approach to the diagnoses of these ticks was established by Nuttall, Warburton, Cooper and Robinson (1911) and used indiscriminately until Schulze (1943) subdivided *rasus* into three subspecies (see later). Consequently, at the present time the status of *rasus* and other forms as yet undescribed presents an interesting problem to the systematist. This uncertainty of structure, coupled with our ignorance of the biology of the *rasus* group, opens up a particularly interesting and virgin field for research, and not a few unknown allied species undoubtedly await discovery.

Nuttall (1911) classified *I. rasus* in the biological group within the genus *Ixodes* in which males and females coexist together on a host that either wanders or does not travel far and in the subgroup where the sexes are found *in copula* on the host. Even so, the published reports show that the host range of the adults of the *I. rasus* group varies from small insectivores (mice, elephant shrews) to leopards, large antelopes, domestic dogs and man. The picture for immature stage-host relationships is more uncertain.

Specimens on which this report is based were obtained from Dr. H. Hoogstraal, NAMRU-3, Cairo, Egypt; Dr. Gertrud Theiler, Onderstepoort Veterinary Research Department; The Museum of Comparative Zoology (through the courtesy of Dr. J. Bequaert); Musée Royal du Congo Belge (through the courtesy of Dr. E. Darteville); Dr. Pierre Morel, Laboratoire Fédéral de l'Élevage George Curasson, Dakar, Senegal; Rocky Mountain

¹ The opinions and statements contained herein are the private ones of the Writers and are not to be construed as official or reflecting the views of the Navy Department or the Naval Service at large.

Laboratory, Montana (through the courtesy of Mr. Glen M. Kohls); Dr. J. Mouchet, Direction des Services de Santé Publique, Yaoundé, Cameroun Français; British Museum (Natural History) through the courtesy of Dr. G. Owen Evans and Mr. E. Browning; Mr. W. Grey, Mazabuka, Northern Rhodesia; Dr. Brazzard, Laboratoire d'Histoire Naturelle, École Nationale Vétérinaire, Toulouse, France.

This work was initiated when the writer (D.R.A.) was in receipt of a Leverhulme Research Award and completed on a visit to East Africa under a Colonial Welfare and Development Grant made available by the Colonial Office. This author wishes to record his thanks to these organizations as well as to members of the East African Veterinary Research Organization (particularly to Miss Jane Walker) for their hospitality, and to U. S. Naval Medical Research Unit No. 3, Cairo, Egypt for their great assistance and many kindnesses.

The following abbreviations are used to denote the sources of the material examined: BM, British Museum (Natural History); CNHM, Chicago Natural History Museum; EAVRO, East African Veterinary Research Organization; GHFN, Nuttall Collection, British Museum (Natural History); HH, Harry Hoogstraal, Cairo; JM, J. Mouchet, Cameroons; MC, Musée Royal du Congo Belge, Tervuren (Belgique); MCZ, Museum of Comparative Zoology; OP, Onderstepoort Research Station; RML, Rocky Mountain Laboratory Collection.

SYSTEMATIC DESCRIPTIONS

IXODES RASUS Neumann 1899

(Figures 1-13)

Ixodes rasmus Neumann (1899), pp. 137-39, Figs. 12-14, described from 3 females and 1 male (cf. *Remarks* below) from Belgian Congo (cf. Bequaert, 1931, who refers type locality to French Equatorial Africa). Nuttall, Warburton, Cooper and Robinson (1911) repeat Neumann's description of the male, and describe another species of female (see under *Ixodes pseudorasus*). Schulze (1943) subdivided *rasus* into three subspecies, viz: *I. rasmus rasmus*, *I. rasmus cumulatimpunctatus* and *I. rasmus eidmanni*. (Cf. *Remarks* below.)

Type material. Originally described by Neumann (1899, pp. 137-39) from three females and a copulating male, from *Hyrax* species collected in "the Congo" in A. Mocquerys coll. 1899. The present labelling of these specimens reads "740. *Ixodes rasmus*, 1 male, 2 females (-1 female) *Hyrax* species, A. Mocquerys coll. 1899. G. Neumann det." An anomalous situation occurs here as Neumann stated that there were three females, whilst the present information states "2-1 females," and accordingly I propose that the remaining female specimen becomes the electotype. Electotype female, and allotype male deposited in the Neumann collection, No. 740, at the École Nationale Vétérinaire, Toulouse, France.

Paratype: 1 female, *Viverra civetta*, Congo Belge. Deposited at the École Nationale Vétérinaire, Toulouse, France, No. 761.

MATERIAL EXAMINED. Total 43 females; 6 males. 1 female (no host data) Dakar, Senegal: 1 female, wild pig, Cameroons, Fr. Berlin Zoo Museum, Dr. Schafer (GHFN—3005): 1 female, *Felis pardus* L., primary forest, Mainyu Bridge, Mamfe, Cameroons 500 ft. alt., 12.5.33. P. Sladen Trust Expedition (BM): 2 females, *Manis tricuspis* (= *Phataginus tricuspis* (Rafinesque)) secondary forest, Bashamii, Mamfe, Cameroons 23.3.33. I. T. Sanderson leg. (BM): 3 females (originally, 6 females according to legend in vial), *Cephalophus leucogaster* Gray, Efeileu, Bulu Country, Cameroons. 28.6.33. I. Sanderson leg. (BM): 6 females, 1 nymph, 8(5)1 N, White mongoose (783 M) Old secondary forest, Bashan. Mamfe Division Cameroons 28.6.1933, P. Sladen Trust Expedition, I. T. Sanderson leg. (BM): 3 females, *Nandinia binotata*, [probably *binotata binotata* (Reinwardt)] high deciduous forest, Mamfe, Cameroons, 30.4.1933. I. T. Sanderson leg. (BM): 2 females, "Schuppentier" (probably *Phataginus*), Lolodorf, Africa, 29.3.1907 (GHFN coll: no number): 1 female, 2 males, *Genetta tigrina* (subspecies not stated), Mongbivalu, 8/1939, Mme. Lepersonne leg. (MC 4502/4506): 4 females (no host data), Simba, (MC 8259 and 8262): 1 male (no host data) Flandrina, 6.3.1928. R. P. Hubsbaert leg. (MC no other information): 1 female, *Cercocebus albigena*, Okongena (Lububu), 22.9.1929, A. Collart leg. (MC 42096), nymphs ?, antelope, Masua, Lububu, 9.9.1929, A. Collart leg. (MC 43372/43386): 1 female, *Aulacodus* (= *Thryonomys* Fitzinger) *swinderianus* Temminck 1827, Aruwimi, Panga, -8.1925, J. Schouteden leg.

(MC 8220 and 8222): 1 female, *Sus* ? Leverville, 1927 (no other data) (MC 46569): 1 female, *Colobus badius badius* (Kerr), N'Dzida, Ivory Coast, 20.9.53. A. Villiers leg. (MCZ): 1 female, *Neotragus pygmaeus*, Yapo, Ivory Coast, A. Villiers leg. (MCZ): 1 male from Mongoose, Mt. Du Chaillu, Mt. Bijou, French Equatorial Africa, 8.8.1951. H. A. Beatty leg. (CNHM 73796) 2 females (no other data), OP coll. 2906: 2 females and 1 male "man and dog," Kumasi, Ashanti (GHFN 928)—this collection is a bulk sample of 9 females and 1 male, i.e. we have no knowledge of which specimens came from man or dog but the two *rasus* forms are readily distinguishable from the 7 female *pseudorasus* forms which are discussed later, with no intermediates: 3 females, "Pangolin or Scaly manis, Mubango, Mabina Forest, Kyagle, Uganda, 4000 ft. Capt. C. R. S. Pitman leg. (BM 6.19. 1-20): 1 female, *Lophuromys aquilus aquilus* (True), Nyika Plateau, Nyasaland, 9.10.1948. A. Loveridge leg. (MCZ): 1 female, *Manis tricuspis* (= *Phataginus tricuspis* (Rafinesque)), Fernando Po. (BM).

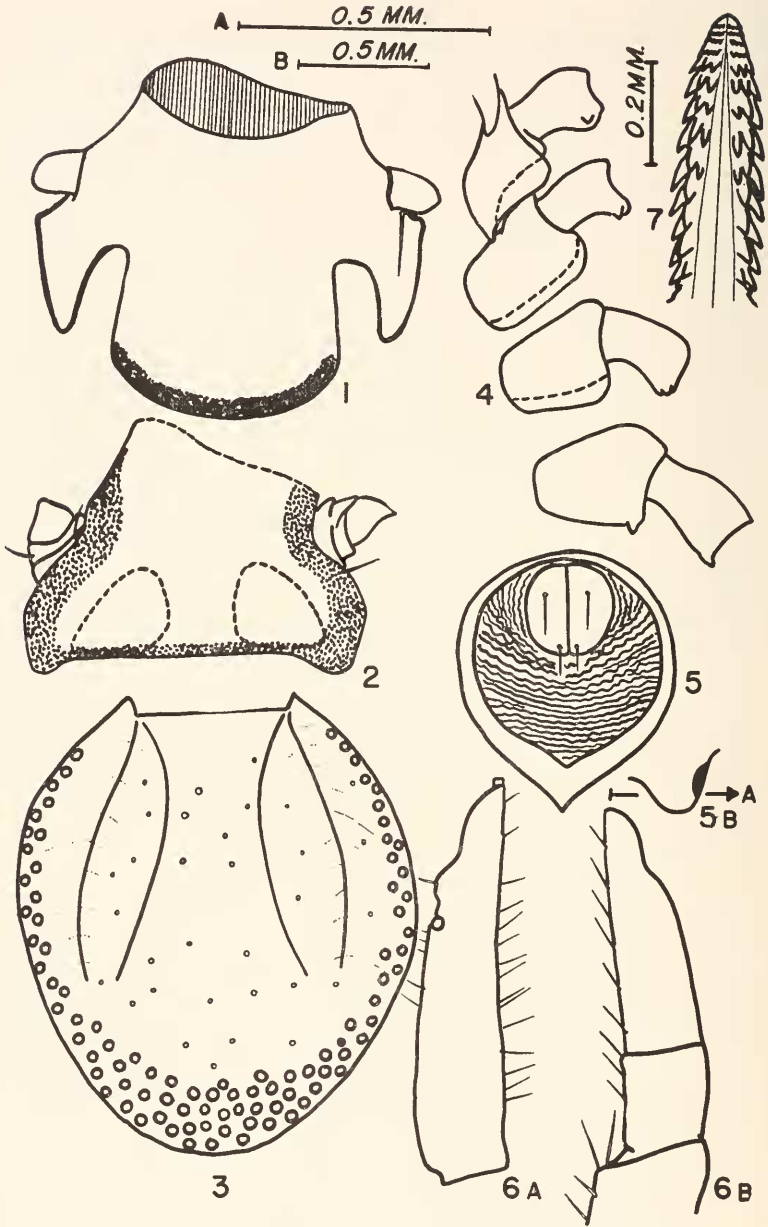
Distribution. From the records we have examined, *Ixodes rasmus* is to be found in many parts of West and Central Africa and is common locally in East Africa. WEST AFRICA. Senegal, Ivory Coast, Gold Coast; CENTRAL AFRICA. Fernando Po, Cameroons, French Equatorial Africa (Bequaert 1931 refers the type locality to French Equatorial Africa, not to the Belgian Congo), Belgian Congo; EAST AFRICA. Uganda, Nyasaland, Northern Rhodesia, Sudan. Previous records of *I. rasmus* from Southern Rhodesia (Nuttall 1916) refer to *I. pseudorasus* and those of Cooley in the Rocky Mountain Laboratory, Montana to *Ixodes pilosus*. The material of the records of Bedford 1929 and 1932 are not available for re-examination.

Hosts. The wide range of hosts for the adults previously given for *I. rasmus* has now become considerably reduced (cf. Hoogstraal, 1956). The immature stage-host relationships must remain in abeyance until such time as the larvae and nymphs are bred and their diagnostic characters ascertained. The present known hosts of the adults are: "wild pig," *Felis pardus*, *Phataginus tricuspis*, *Cephalophus leucogaster*, white mongoose, *Nandinia binotata*, *Genetta tigrina*, *Cercocercus albigena*, antelope, *Aulacodus* (= *Thryonomys*) *swinderianus*, *Colobus badius*

badius, *Neotragus pygmaeus*, dog, man, *Lophuromys aquilus aquilus*, *Hyrae* (type specimen), *Viverra civetta*.

Biology. Unstudied.

Remarks. The Neumann collection at the École Vétérinaire, Toulouse, contains in addition to the electotype and the paratype two lots of specimens identified by Neumann as *I. rasus* and bearing the following data: (1) "Ousambara (Afr: or Allem:) det. by G. Neumann 1900, 1 female," and (2) "*I. rasus* Nn. Bismarckburg (Togo). Conradt leg. G. Neumann det. 1899. Berlin Mus." 1 female. The first specimen is *I. pseudorasus*, the second *I. oldi* Nuttall 1913. Schulze (1943) indicated that circular anal grooves are characteristic of this species and in some instances they may be drawn out or narrowed posteriorly. This is in fact true for the electotype (see description). To what extent Schulze (1943) was justified in dividing *rasus* into three subspecies is problematical. Schulze's *I. rasus rasus* undoubtedly refers to Neumann's *rasus* and he adds little to Neumann's description of the male beyond directing attention to the lobes on the ventral side of the basis capituli and the correction of the position of the genital orifice. Similarly he gives the same characters for *I. rasus eidmanni* stating that they are "more strongly chitinized (!) and darker," the denticles of the hypostome with a small apical hook (true also for *I. rasus*), proximity of sensory organs in the integument and absence of a definite "peripheral zone" of the integument. These distinctions would appear to me to be of doubtful value in establishing a subspecies, particularly as the numbers examined were inadequate. This subspecies has been collected at Rio Muni and Spanish Guinea. I have no specimens of *I. rasus* from either source and the only specimens from Rio Muni constitute a distinct new species (*Ixodes muniensis*) which is described later. I have failed to see the original material of *I. cumulativimpunctatus* and have seen nothing in the extensive African tick fauna investigated that is comparable with it. The occurrence of the "sieh-lhaar" in the capsule of Haller's organ in *I. rasus* (see Schulze 1943) is applicable to a large number of *Ixodes* ticks, and the break in the chitin within the depression (trough), to which Schulze alludes, is due to a failure to appreciate that the cuticle



in this region is saddle shaped in the majority (if not all) *Ixodes* ticks (Arthur, 1956).

Redescription of the electotype FEMALE. Body well engorged, dried specimen, dark red color, sclerotized parts dark red brown.

CAPITULUM (Figures 1, 2). Length of *basis capituli* to hypostomal base, 0.43 mm., breadth of basis across dorsal ridge, 0.62 mm., sub-triangular, straight lateral margins slightly divergent to palpal base, postero-lateral margin produced into cornua which are broader basally than long, rounded apically; well-defined posterior margin, straight and salient, black pigmentation peripherally (Figure 2). Surface gently convex with reticulate sculpturing, lateral surface slightly curved. *Porose areas* strongly depressed, sub-triangular in outline separated by a distance equivalent to their greatest breadth. *Basis capituli* broad ventrally; auriculae as large strong blunt retrograde processes, anterior angle sharp, posteroventrally directed and stand well out from the periphery of the basis. Distal part of capitulum in electotype broken off. *Hypostome* (Figure 7) 0.56 mm. in length, tapering apically, profile curved; dentition from base to apex, 1 row of 1/1; 4 rows of 2/2, 5 rows of 3/3, 4 rows of 3/3, slight corona present, denticles long, hook-like. (Hypostomal structure determined from females collected in Simba, MC 8259 and 8262.)

SCUTUM. Broadly ovate (Figure 3) but widest in front of mid-length, tapering more strongly to rounded posterior margin; colour, dark red-brown, surface reticulate. *Cervical grooves* as wide depressions most pronounced about mid-way along; cervical field flat, surface is strongly elevated lateral to these grooves but without indication of lateral ridge; *punctations* large, deep and close together marginally, smaller and more widely separated elsewhere.

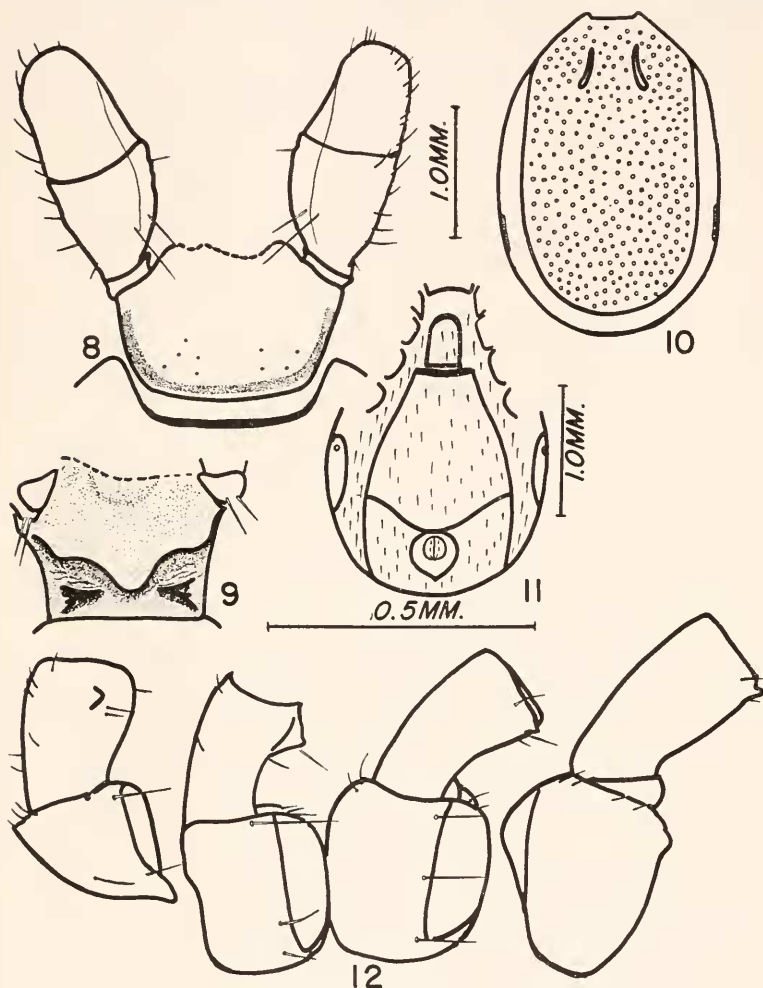
Figs. 1-7. *Ixodes rarus*, female: 1. Capitulum, ventral; 2. Capitulum, dorsal; 3. Scutum; 4. Coxae and trochanters I-IV; 5. Anal plate; 5B, diagram of anal plates in side view as drawn in Figure 5. Male: 6A. Tarsus I; 6B. Tarsus IV; 7. Hypostome of female. (Scale A refers to Figs. 1, 2, 4-7; scale B refers to Fig. 3.)

LEGS. Moderately long and stout, distal segments missing from first three legs on right side, similarly on second leg on left side. *Coxae* slightly convex, reticulately patterned, coxae I, II and III syncoxae, coxa I with distinct short broad internal spur, coxa IV with external spur, short, broad; blunt tapering trochanter spurs on legs I to IV (Figure 4). *Tarsi* missing in electotype and paratype specimens. In specimens from Simba (MC 8259 and 8262), long, tapering with slight hump in front of Haller's organ on tarsus I; similar humps on succeeding tarsi; length of tarsus I, 0.85 mm., metatarsus I, 0.45 mm.; tarsus IV, 0.71 mm., metatarsus IV, 0.54 mm. (Figures 13A, B). *Genital opening*, level with the third coxal interspace, genital apron bilobed. *Anal opening* located far back on the body, convex anal valves with two pairs of fine long hairs, anal grooves circular, closed, and *drawn out into a point* in the electotype specimen (circular in paratypes and other specimens examined); in Figure 5 the region bounded by groove is deeply sunk in front so that the anal valves are almost vertical; this sinking is less pronounced posteriorly. *Spiracular plate* transversely oval, macula central, goblets small, numerous. Body hairs fine, short, sparse.

Redescription. MALE. Elongate oval body, narrowing slightly anteriorly, posterior extremity broadly rounded, length excluding basis, 2.56 mm., breadth 1.6 mm. Legs, scutum, dark reddish brown.

CAPITULUM (Figures 8, 9). Greatest breadth of *basis capituli* posterior to palpal insertion, 0.43 mm., much broader than long, and converge by rectilinear and curved postero-lateral margins to a slightly convex, salient posterior border; surface flattened, brown in colour, bordered by darker band of pigmentation (stippled in Figure 8) which does not extend to the periphery, small scattered distinct pores. *Palpi* short, broad, length of article 2, 0.22 mm., article 3, 0.23 mm., greatest width of 0.19 mm. at junctions of articles 2 and 3; lateral margins almost straight, mesial profile of article 2 convex, that of article 3 straight, tapering to broadly rounded apex; pronounced flanging effect ("roll collar") along meso-dorsal edge of article 2, continued for some distance along article 3; mesial surface of palp very slightly concave; *hairs* short to moderate in length, numerous, par-

ticularly on outer side, article 1 bears mesial spur. In ventral view *basis capituli* broad, traversed by undulating ridge; mesial lobe of which is more strongly convex than those on either side,



Figs. 8-12. *Ixodes rarus*, male: 8. Capitulum, dorsal; 9. Capitulum, ventral; 10. Dorsum; 11. Venter; 12. Coxae and trochanters I-IV.

steep slope from ridge to hypostomal base, behind ridge surface declivitous, broken by irregular ridges and particularly by two sharp triangular elevations (Figure 9). (The hypostome and chelicerae are missing, but Neumann (1899) gives the length of the former as 0.55 mm.)

SCUTUM (Figure 10). Length 2.33 mm., breadth 1.33 mm. Elongate, sides straight between the sharply angled antero-lateral border and the broad rounded extremity; surface convex, dark reddish-brown colour, marginal fold white, of uniform width, 0.175 mm. wide [Neumann (1899), repeated by Nuttall *et al.* (1911) states that body fold is narrow (0.1 mm.)]. Cervical grooves faint anteriorly, leading into short, moderately deep, wide depressions. *Punctations* of moderate size and depth, uniformly distributed, pronounced. *Ventral plates* (Figure 11): pregenital plate longer than broad, posterior and lateral borders straight, anterior margin rounded; median plate large, diverging quite strongly to junction with adanal plates; sides and posterior margin sinuous; adanal plates not joined behind anal plate, latter circular *but drawn out into a small but distinct point behind*, as in female; numerous punctations of similar form to those on scutum. Abundantly supplied with short hairs, which are shorter than those on the epimeral plates. *Anus* eccentric, nearer anterior rim of anal groove.

LEGS. Long, last two segments of fourth pair of legs extend beyond posterior limits of body. *Coxae* (Figure 12). Large, shiny, dark reddish brown, slightly convex and somewhat rugose, such hairs as are present, long; coxae I to III syncoxae; *coxa* I short, tapering spur on posterointernal angle, external spur short and broad on *coxae* IV, *coxae* II and III unarmed; distinct tapering trochanter spurs on legs I to IV; *tarsi* (Figures 6A, B) much as in female; length of tarsus I, 0.79 mm.; tarsus IV, 0.65 mm.

IXODES PSEUDORASUS new species

(Figures 14-31j)

Ixodes rarus pro parte Nuttall, Warburton, Cooper and Robinson 1911, Pt. II, pp. 229-30, Figures 225-226. Described females from cattle in

Uganda (GHFN 877d), from leopard, Obuasi, S. Ashanti (GHFN 503) and from man and dog (GHFN 928) — this last record is discussed under host list of *I. rasus*. It would appear that these writers did not see the types of Neumann and state that their description differs from that of Neumann (1899) in respect of the female.

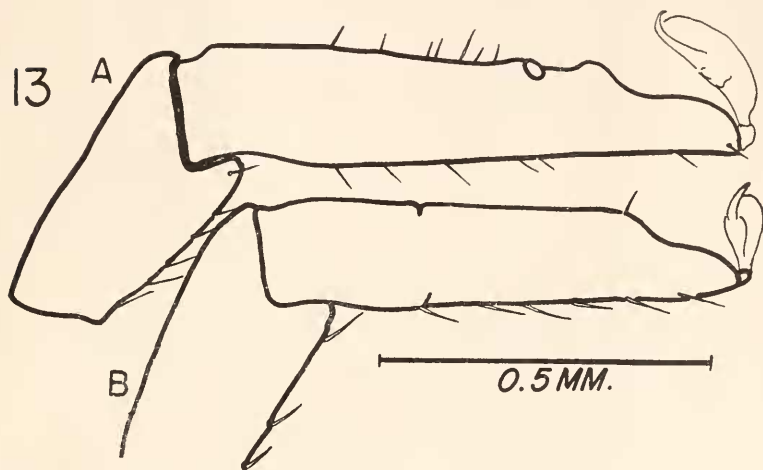
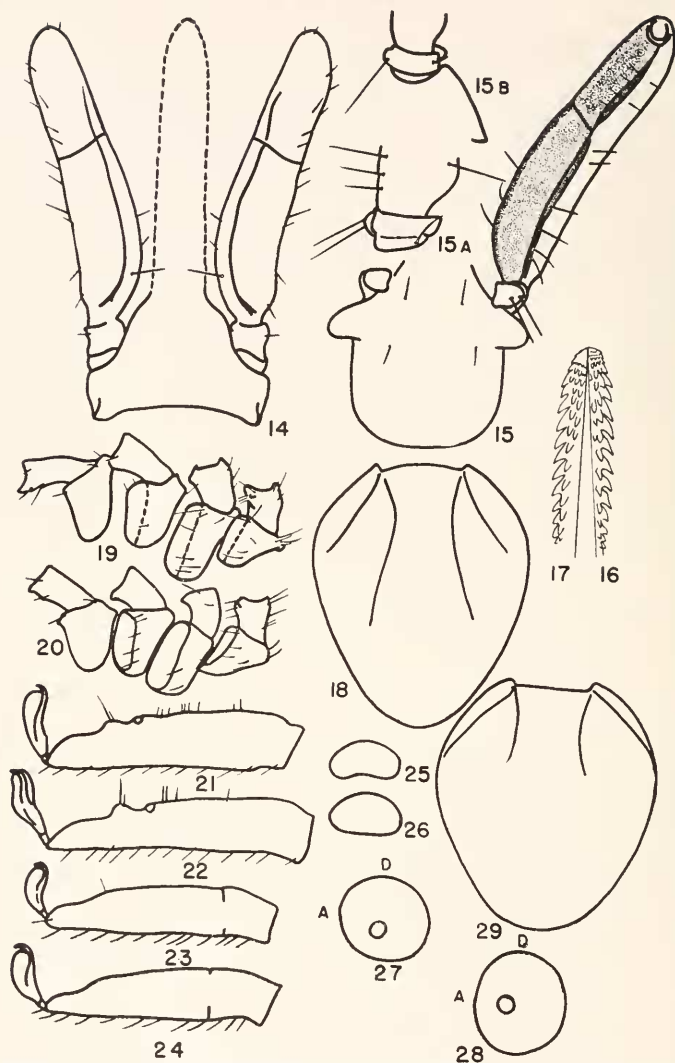


Fig. 13. *Ixodes rasus*, female: A, Tarsus and metatarsus I; B, Tarsus and metatarsus IV.

MATERIAL EXAMINED. Two females, goat, Beeba-Sharo, Belgian Congo, 23.V.1913, F. Harker *leg.* (GHFN 2353): 2 females, (no host cited) Ibembo, 6.7.50 (MC 70016): 4 females, dog, Port Franqui, -2.1934, Dr. Bouvier *leg.* (MC 38651); 1 female, *Okapia*, Epulu, 1933, R. Fr. Hutsebaut *leg.* (MC 46515/46518): 6 females, *Okapia*, Epulu, 1938, R. Fr. Hutsebaut *leg.* (MC 46674/46662); 3 females, *Okapia johnstoni*, Epulu River, Ituri District, Belgian Congo, P. Putnam *leg.* (BM): 2 females, *Potamochoerus porcus*, Ibembo, 6.7.1950, R. Fr. Hutsebaut *leg.* (MC): 1 female, *Procapra* ? Burunga, Kiru, -12.1925, Dr. Schouteden *leg.* (MC 8178 & 8182): 1 female, 3 nymphs, *Tragel-*



Figs. 14-29. *Ixodes pseudodorus* and variant form; 14-15 female of *I. pseudodorus*: 14. Capitulum, dorsal; 15. Capitulum ventral; 15A, B. Palpal article 1, dorsal and ventral; 16, 17. Hypostome, *I. pseudodorus* and variant form respectively; 18. Scutum (*I. pseudodorus*); 19, 20. Coxae and trochanters, *I. pseudodorus* and variant form respectively; 21. Tarsus I (*I. pseudodorus*); 22. Tarsus I (variant form); 23. Tarsus IV (*I. pseudodorus*); 24. Tarsus IV (variant form); 25. Genital apron (variant form); 26. Genital apron (*I. pseudodorus*); 27, 28. Spiracular plate, *I. pseudodorus* and variant form respectively; 29. Scutum (variant form). The letters A, D, P, V refer to anterior, dorsal, posterior and ventral directions, respectively.

aphus scriptus, Kibombo, Belgian Congo, (MCZ): 2 females, Buffel, Ibembo, 2.8.1950, R. Fr. Hutsebaut *leg.* (MC 67307): 1 female, cow, Costermansville, Vereommen 1950 (MC 61269): 2 females, *Potamochoerus porcus*, Ibembo, 6.7.1950, R. Fr. Hutsebaut *leg.* (MC 70016): 2 males, 2 females, *Cricetomys gambianus*, Mt. Selinda, Southern Rhodesia -12.55 (OP 2433 ii): 3 females, man, Mt. Selinda, Sth. Rhodesia, 23.9.55 (OP 2433 v): 1 female, 5 nymphs, Chevrotain, north central Rio Muni, 23.4.1954, K. C. Brown *leg.* B.22832, gift of R. Traub, (HH): 1 nymph ? forest antelope, north central Rio Muni, 18.5.1941, gift of R. Traub, (HH): 4 females, leopard, Obuasi, Ashanti, -12.1908 (GHFN 503), 7 females, man or dog? -10.1907, Dr. Graham *leg.* (GHFN 928): 1 female, Gold Coast, no other data (Entomol. Research Com. Cat. No. 762a. 14.4.1922. S. BM): 2 females, *Cricetomys gambianus*, Bibianaha, Gold Coast, 3.12.1911. N. C. Rothschild *leg.* (BM): 6 females, Sierra Leone (no other data. BM): 1 female, *Cephalophus*, Tanga, German East Africa (BM); 2 females, Umboyasi River, Mgongo, British East Africa, no other data (BM): 1 female, cattle, which came from Bukedi to Mpumu, Uganda; 10.9.1909, D. Bruce *leg.* (GHFN 877d): 1 female, 10 nymphs, Bushbuck, Kyagwe, Uganda, N. W. Mettam *leg.* (GHFN 3829a): 1 female, giant rat, Mubango, Mambina Forest, Kyagle, Uganda 4000 ft. alt., 1932, Capt. C. R. S. Pitman *leg.* (BM 6.19.21): 3 females, *Centropus* (?) *superciliosus* Loande, Kampala, Uganda, -9.39. (BM): 1 female, several nymphs, Pygmy Antelope, *Neotragus moschatus akeleyi*, Mt. Kenya, 7000', Kenya: 9 females, cattle, Kitale, A. Wiley *leg.* 5.4.49 (EAVRO): 19 females, *Boocercus eurycerus*, Kabolet Forest, near Kapenguria, 23.2.56, S. F. Barnett *leg.* (EAVRO): 3 females, *Cricetomys*, Mlange, Nyasaland -10.1914 (BM 13.12.30. 29-30): 3 females, *Mungos melanurus*, Zomboe, Nyasaland 1915 (BM 1915. 12. 30, 3/-33): 1 female, 1 male "tick bird" stomach ? Tanganyika, (Vet. Lab., Kabete): 1 female, Dakar, Senegal (No other data).

Distribution. The general pattern of the distribution of this species follows closely that of *I. rasus*, except that as far as present valid records are concerned there are far more records from East Africa. WEST AFRICA. Senegal, Ivory Coast, Gold Coast. CENTRAL AFRICA. Rio Muni, Belgian Congo. EAST AFRICA. Uganda, Kenya (British East Africa), Tanganyika (German East Africa), Nyasaland, Southern Rhodesia.

Description. FEMALE. Body of unfed female short oval, broadest at about the posterior third.

CAPITULUM (Figures 14, 15). *Basis capituli* sub-triangular, posterior margin straight or slightly undulate, sides curved, surface convex, broad, rounded, very short broad cornua; *porose areas* pear-shaped, less frequently oval, separated by a distance less than their maximum diameter, when oval usually set obliquely to long axis of body. *Palpi* long, lateral profile slightly concave except for slight baso-lateral swelling, mesial profile of article 2 broadly curved, that of article 3 straight, apex rounded with inner angle acute, outer angle rounded, meso-dorsal margin of article 2 and proximal part of article 3 flanged, palpal hairs moderately long basally on article 2, shorter on article 3. Ventrally (Figure 15) *basis capituli* has straight lateral margins, with postero-lateral and posterior margins broadly rounded, two pairs of hairs in position indicated in Figure 15; surface either flat or gently convex; auriculae form broad flat lobes with rounded apices. Palpal article 1 (Figures 15A, B) drawn out into a mesodorsal flange and a ventro-lateral lobe supplied with a long hair; article 2 with few hairs of moderate length basally, hairs shorter and more abundant on article 3; inner face of article 2 flat, that of 3 slightly concave. Length of capitulum, 1.1 mm.; breadth of capitulum across dorsal ridge, 0.48 mm.; breadth of capitulum across auriculae, 0.57 mm.; length of palpal article 2, 0.47 mm.; greatest breadth of palpal article 3, 0.16 mm.; length of palpal article 3, 0.37 mm. *Hypostome* (Figure 16) long, gently curved profile lines, rounded at the tip, small "corona"; dentition, 2 rows of 4/4, 4 rows of 3/3, and 7 rows of 2/2 teeth.

SCUTUM (Figure 18). Length 1.42 mm., breadth 1.15 mm., widest in front of middle, curving strongly to scapular base, less strongly posteriorly, sides almost rectilinear and terminate in a rather narrowly curved posterior margin, scapulae short, pointed, emargination slight; *lateral carinae* slightly indicated, short, ceasing just beyond the greatest width; *cervical grooves* superficial, shallow, not reaching to postero-lateral border. *Punctations* consisting of closely set groups of small pores, uniformly distributed, short hairs.

LEGS. Moderate length; *coxae* I, II and III syncoxae: coxa I sub-triangular with well developed areae coxales supplied with

stout hairs, other hairs fine, variable in length, internal spur lacking, the postero-internal extremity rounded, coxae II and III longer than broad, supplied with hairs of uniform length, coxa IV subtriangular, spurs absent; trochanters I-III with short, broad, blunt spurs. *Tarsi* long, tarsus I, 0.74 mm., tarsus IV, 0.67 mm. (Figures 21, 23) tapering fairly gradually to slight hump beyond Haller's organ, pad almost as long as claws.

GENITAL OPENING. Between coxae IV, covered with translucent unilobed genital apron (Figure 26) genital grooves horseshoe-shaped.

ANAL GROOVES. Situated far back, rounded and drawn out posteriorly into a small point.

SPIRACULAR PLATE (Figure 27). Round, macula almost antero-ventral in position.

Variants. The only consistent variant forms, which I have encountered are 9 females collected from "Vache, Costermansville, Vercommen 1950, MC coll. 69733."

Description. **FEMALE.** These specimens are dark brown and the alloscutum bears scattered short white hairs.

CAPITULUM (Figures 30, 31). Length 0.98 mm., breadth across *basis capituli* just behind insertion of palpal article 1, 0.54 mm.; surface flattened, *porose areas* subtriangular in outline, superficial, interporose interval about equal to maximum breadth; marginally *basis capituli* heavily pigmented, almost black, lateral margins diverge anteriorly, posterior margin straight, cornua short, broad basally and rounded apically; *palpi* relatively short and broad, article 1 short, broader than long, internal mesial spur present (Figure 30); article 2 swollen basally thence lateral profile concave to suture line with article 3, that of article 3 nearly straight and terminating in a broad rounded apex, mesially article 2 gently convex, article 3 straight and tapering to tip; *hairs* long on lateral and mesial profile of article 2, shorter on article 3; mesially, palp drawn out into a broad flange and long hairs arise on its mesial face, i.e. above and below the flange, length of article 2, 0.4 mm., article 3, 0.31 mm. Ventrally *basis capituli* broad, auriculac much reduced and form flattened projections (cf. with *I. pseudorasus*),

surface generally flat as far back as slight posterior depression, beyond which it rises strongly (stippled in Figure 31). Two pairs of hairs in positions indicated in Figure 31; posterior margin broadly rounded. *Hypostome* (Figure 17) long, rounded apically, largest teeth about mid-length, strongly pointed, dentition from base to apex, 7 rows 2/2, 4 rows 3/3, 2 rows 4/4, 2 rows 5/5 teeth, small "corona," median triangular unarmed area.

SCUTUM. Mean scutal dimensions are 1.3 mm. x 1.17 mm. (cf. with *I. pseudorasus*, 1.4x1.1), and the scutum is broadly rounded posteriorly (Figure 29), surface elevated between the short *cervical grooves*; *lateral carinae* ill-defined, antero-lateral margins slope steeply, scapulae short, rounded, emargination slight; *punctations* small, shallow, most abundant posteriorly but even so well separated, less numerous in the cervical field and between the cervical grooves and the lateral carinae.

LEGS. Long and strong, *coxa* I with short, salient trenchant internal spur, *coxa* IV with short rounded external spur (Figure 20), trochanter spurs short, broad, pointed; *tarsus* I (Figure 22) long, narrow, slightly tapering, strongly humped beyond Haller's organ, *tarsi* II-IV with progressively weaker humps, hairs progressively shorter and stouter from leg I-IV; length of tarsus I, 0.76 mm., tarsus IV (Figure 24), 0.67 mm.

SPIRACULAR PLATE. Almost rounded, macula anteriorly placed, large number of moderately large goblets (Figure 28).

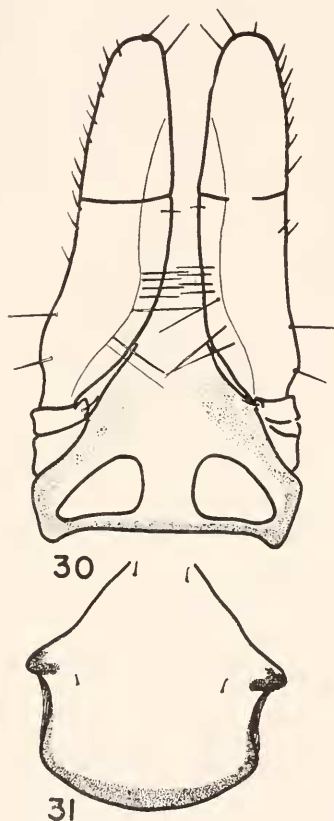
GENITAL APERTURE. Between coxae IV: genital apron slightly concave (Figure 25) (cf. with *I. pseudorasus* and *I. rasus*).

ANAL GROOVES. Circular.

Description. **MALE.** From bovines, Sura, Arusha, Tanganyika, 13 Dec., 1955. F. W. White *leg.*

BODY. Elongate oval, greatest width slightly in front of the middle, surface more steeply rounded posteriorly. Colour (of alcohol preserved specimens) alloscutum uniformly dark reddish brown, with many fairly long brownish white hairs especially on the periphery, hairs generally closely adherent to surface, scutum and basis capituli deep red brown with paler posterior and postero-lateral margins, legs and palpi less heavily pigmented.

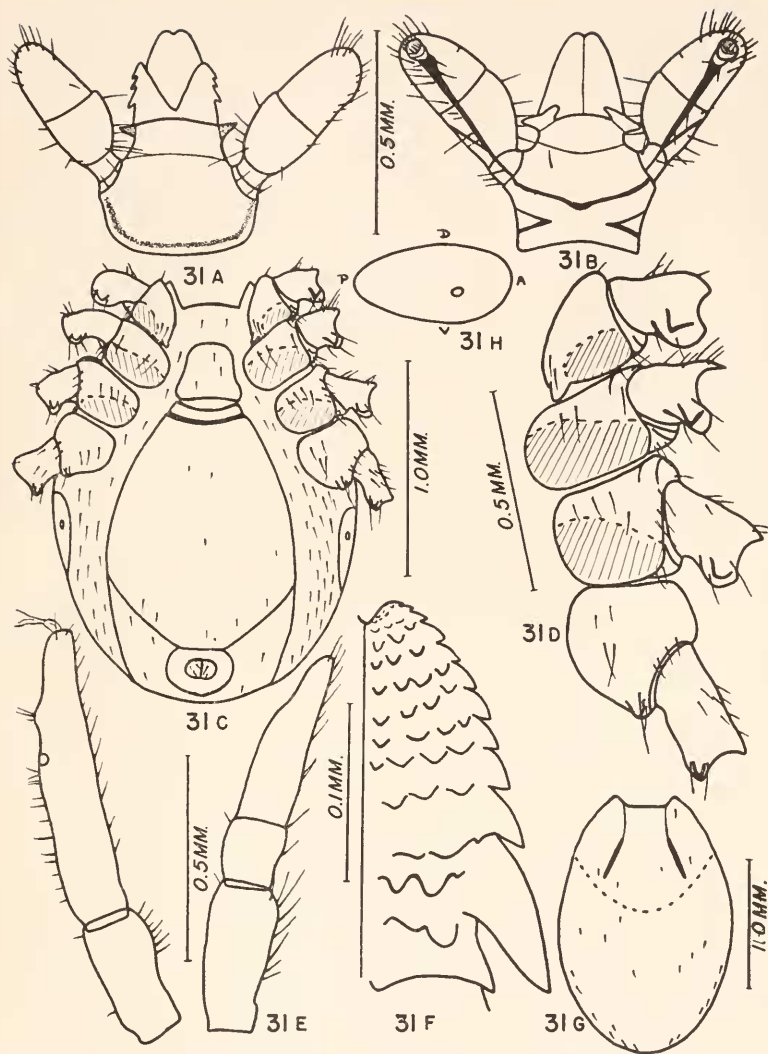
CAPITULUM (Figures 31A, B). *Basis capituli* about 1-3 times as broad as long, length 0.26 mm., breadth 0.34 mm., dorsal ridge broadly convex, more sharply rounded postero-laterally and thence to almost straight divergent margins, greatest width of basis capituli immediately behind palpal insertions. Surface of basis capituli reticulately patterned, elevated in mid-line behind anterior cheliceral foramen, broad depression on each side running antero-laterally from posterior margin to palpal insertions,



Figs. 30, 31. *Ixodes pseudorasus*, variant form, female: 30. Capitulum, dorsal; 31. Capitulum, ventral.

sloping away ventrally around base of latter, posterior margin weakly elevated. *Palpi* broad, short, length to breadth as about 2.6:1.0, taper from base to broadly rounded apex, articles 2 and 3 of about equal length, about 0.21 mm., lateral profile of article 3 indented baso-laterally thence slightly sinuous to the suture line between articles 2 and 3, that of article 3 almost straight; mesial margin of article 2 as a broad arc of a circle, that of article 3 straight and convergent to the rounded apex; greatest breadth of 0.16 mm. just below suture line of articles 2 and 3, hairs of moderate length and quite numerous apically. Ventrally posterior border concave, postero-lateral angles steep, lateral margins gently concave, diverging to palpal insertion; transverse ridge strongly defined, with auriculae as faintly curved and flange-like edges, connected by a median, broad, tongue-like ridge; basis capituli slightly longer than broad, less heavily pigmented than dorsal surface except for median tongue and auricular elevations of the ridge and periphery; surface slopes to hypostomal base from the transverse ridge, but short and declivitous behind the latter; two triangular elevations on either side of a depression behind, pair of erect hairs situated lateral and posterior to hypostomal base, mesial surface of both palpal articles 2 and 3 concave, that of 2 irregularly so. *Hypostome* (Figure 31F): broad, with indented apex, rounded on either side of the indentation, 12 lateral teeth increasing in size from apex to pre-basal teeth, basal tooth angular, teeth arranged as 2-3 rows of 3/3 files, 2 rows of 4/4 files, 4 rows of 5/5 files, pre-basal and basal tooth subtended by two crenulations each; length 0.23 mm.

SCUTUM (Figure 31G). Colour uniformly deep red brown, with smaller less heavily pigmented patches antero-lateral to scapulae. Elongate oval, tapering a little anteriorly, steeply rounded posteriorly, greatest breadth approximately at mid-length, length 1.93 mm., breadth 1.30 mm., distance between the scapulae, 0.38 mm., antero-lateral margins behind scapulae undulate, lateral and postero-lateral margins curved, *lateral carinae* lacking, *cervical grooves* faint and very shallow, most apparent in front of the pseudoscutal outline, weak behind the scapulae.



Figs. 31A-H. *Ixodes pseudorasus* male: A. Capitulum, dorsal; B. Capitulum, ventral; C. Opisthosoma, ventral; D. Coxae I-IV; E. Tarsi I and IV; F. Hypostome; G. Scutum; H. Spiracular plate.

Punctations numerous, subequal, shallow, small, more or less evenly distributed over the surface. Scapulae broad based, short, subtriangular with blunt apices, emargination moderate. *Hairs* white, small, fairly numerous, uniformly distributed over the surface.

VENTRAL PLATES (Figure 31C). Pregenital plate slightly concave behind, convergent sides, rounded anteriorly, extends from anterior margins of coxae III to posterior margin of coxae I; median plate about one and a third times as long as broad, greatest breadth very near to posterior margin, sides curved and convergent to genital opening; adanal plates subrhomboidal with sharp anterior angles, posterior junction between adanal plates on either side ill-defined or absent; anal plate transversely oval and drawn out into a small point posteriorly.

LEGS (Figure 31D). Broad, long, *coxae* I-III with extensive syncoxal areas; all coxae large and broad, coxae I with strong, conical internal spur, II and III unarmed, IV with smaller rounded, broad external spur, several long hairs on each coxa, with posterior margins of coxae I-III strongly trenchant, trochanters I and II with large, broad-based spurs, III with a similar but more flange-like spur, IV with smaller, more slender pointed spur: *tarsi* (Figure 31E) long with slight hump, length of tarsus I, 0.67 mm., metatarsus I, 0.32 mm., tarsus IV, 0.57mm., metatarsus IV, 0.38 mm.

SPIRACULAR PLATE (Figure 31H). Large, elongate oval, broadly rounded in front, narrower behind, long axis parallel to that of body, length 0.36 mm., breadth 0.22 mm., macula antero-ventral.

GENITAL ORIFICE. On a level with the anterior edges of coxae III, genital apron slightly indented.

Hosts of Ixodes pseudorasus. Leopard, goat, cattle, bushbuck, *Neotragus moschatus akeleyi*, man, dog, *Cricetomys gambianus*, *Cephalophus*, *Mungos melanurus*, giant rat, *Okapia* (which appears to be a frequent host in Belgian Congo), *Centropus superciliosus*, *Neotragus pygmaeus*, *Potamochoerus porcus*, *Tragelaphus scriptus*, "tick-bird," Chevrotain, forest antelope, bovines.

Biology. On larger mammals the adults occur on the ears and thighs of hosts. Immature stages probably occur on small mammals but until breeding experiments of these stages are completed it is inadvisable to name possible hosts.

Related species. Confusion regarding the *Ixodes rarus* group has arisen because of the acceptance of the closed anal groove as the sole diagnostic character, which is based on the key prepared by Nuttall, Warburton, Cooper and Robinson (1911). At present we recognize the following five species having closed circular grooves: *I. rarus* Neumann, *I. pseudorarus*, sp. nov., *I. muniensis* sp. nov. *I. procaviae* sp. nov. and *I. thomase* sp. nov. The affinities between *rarus* and *pseudorarus* are to be found only in the form of the anal groove and the long palps. A comparison of the descriptions and figures reveal that the differences in the form of the auriculae, the spurs on coxae I and IV and in the shape of the genital apron constitute distinctive characters. Both species have a similar geographical range and if *I. rarus* and *I. pseudorarus* are to be considered as variations within the species, as suggested by Nuttall *et al.* (*loc. cit.*) then all grades of intermediates would be expected. This is not so and out of 140 females examined 43 belong to *I. rarus* and 97 to *I. pseudorarus* with no trace of intermediate forms. Whether the variants of *I. pseudorarus* from Costermansville, all of which agree among themselves, should have subspecific rank is problematical as only nine females were available for examination, and far more collecting for this tick is desirable.

Remarks. Nuttall, Warburton, Cooper and Robinson (1911) base their description on females from Uganda (GHFN 877a), Oubasi (GHFN 503) and from man and dog, Kumasi, Ashanti. It would appear that these authors did not see the type and concluded that their description of the female differed from that of Neumann (1899).

IXODES MUNIENSIS sp. nov.

(Figures 32—51)

Holotype. Female, from *Cephalophus* sp. "Mongele," Epulu River, Ituri district, Belgian Congo, P. Putnam *leg.* Deposited in Museum of Comparative Zoology, Harvard University.

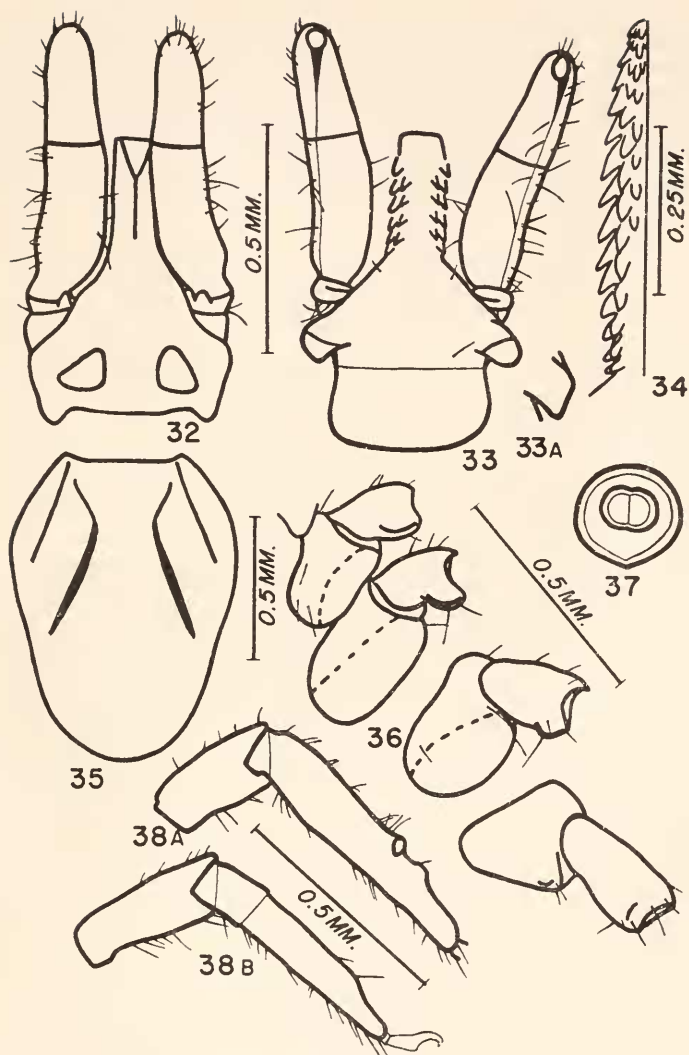
Paratypes. Total 3 females, 9 nymphs and 8 larvae, all from the same host as the holotype and deposited in the Museum of Comparative Zoology, Harvard University.

MATERIAL EXAMINED. Total 13 females, 15 nymphs, 8

larvae. 1 female, 3 nymphs ex Duiker, north central Rio Muni 24 May, 1954, K. C. Brown *leg.*, gift of Col. R. Traub to HH No. B.22842; 1 female, 1 nymph, tabby cat, north central Rio Muni, 23 April, 1954, K. C. Brown *leg.*, gift of Col. R. Traub to HH No. B.22836; 3 females, 2 nymphs, forest antelope, north central Rio Muni, 10 June, 1954, K. C. Brown *leg.* gift of Col. R. Traub to HH No. B.22845; 1 female, *Neotragus pygmaeus*, Yapo, Ivory Coast, A. Villiers *leg.* (MCZ); 1 female, *Felis pardus*, primary forest, 12.5.1933, 500 ft. Mainyu Bridge, Mamfe, Cameroons, I. T. Sanderson *leg.* P. Sladen Trust Expedition (BM 1954 6.14.52); 2 females, tube No. 20 (no host data); Yokadouma, Cameroons, 30.5.55 (JM).

Description. FEMALE. Body, oval-oblong. Alloscutum cream, few short curved white hairs in alcohol preserved specimens, sclerotised parts medium brown, except for more heavily pigmented basis capituli, maximum width slightly in front of spiracle; anal aperture near posterior border; genital orifice level with posterior edge of coxae IV, genital apron unilobed; scutum reaches back beyond half the opisthosomatic length in unfed or partly fed specimens.

CAPITULUM (Figures 32, 33). *Basis capituli* deep reddish-brown, approaching black peripherally; posterior margin between cornua slightly convex, cornua large, sub-triangular, rounded apices; lateral margins slightly divergent to greatest width at palpal base; surface of basis reticulately patterned, elevated in mid-line, slightly convex to antero-lateral margins being more emphasized near the hypostomal base. *Porose areas* indistinct, sub-triangular, shallow, inter-porose length about equal to breadth of porose areas. *Palpi* long, rounded apically, tapering most strongly distal to suture line between articles 2 and 3, lateral profile of article 2 swollen latero-basally, thence gently concave to suture line; mesial profile of article 2 convex proximally, greatest breadth occurs about half-way along article 2. article 1 with prominent dorsally-directed flange-like projection (Figure 32), *hairs* long, fine, especially laterally, fewer in number mesially. Ventrally *basis capituli* slightly longer than broad, greatest breadth across auriculae, posterior border broadly curved, lateral borders slightly constricted (Figure 33), auriculae large, flat, broad-based, lobes, directed ventrally, pair of small



Figs. 32-38B. *Ixodes muniensis*, female: 32. Capitulum, dorsal; 33. Capitulum, ventral; 33A. Variation in the auricular form of the female; 34. Hypostome; 35. Seutum; 36. Coxae and trochanters I-IV; 37. Anal plate; 38A. Tarsus and metatarsus I; 38B. Tarsus and metatarsus IV.

hairs mesial to auriculae, similar pair posterior and lateral to hypostomal base. Palpal article 1 produced into a prominent pointed spur ventro-laterally and supplied with two hairs; mesial surface of article 2 flat, that of article 3 slightly concave. *Hypostome* (Figure 34), long, tapering, slender, apex rounded; dentition from base to apex consists of six rows of $2/2$, 6 rows of $3/3$, 2 rows of $4/4$, small "corona."

Measurements (in mm.) of 10 females
of *I. muniensis*

	Holotype specimen	Average	Smallest	Largest
Length of capitulum from dorsal ridge	0.31	0.31	0.30	0.32
Breadth along dorsal ridge	0.35	0.36	0.34	0.39
Breadth across auriculae	0.46	0.45	0.41	0.48
Length of palpal article 2	0.32	0.32	0.29	0.34
Length of palpal article 3	0.25	0.24	0.23	0.27

SCUTUM (Figure 35). Medium brown colour in alcohol preserved specimens; long, greatest width anterior of mid-length, antero-lateral margins gently convex, postero-lateral margins weakly concave before terminating in rounded posterior margin; *lateral carinae* as short ridged elevations not extending to the margins, lateral field slopes gently from the ridge; *cervical grooves* shallow, becoming broadest about mid-length, not attaining postero-lateral border, convergent at first then divergent postero-laterally. *Punctations* equal, moderate-sized, distinct, shallow, more numerous posteriorly than anteriorly, absent beyond carinae. Scapulae very short, broad, blunt, emargination almost negligible, hairs few, scattered, longer and more numerous anteriorly between cervical grooves.

Measurements of scutum of 10 females (in mm.)

	Holotype female	Average	Smallest	Largest
Length of scutum	1.08	1.09	1.02	1.16
Breadth of scutum	0.76	0.80	0.72	0.83

LEGS. Long, slender, *coxae* I, II, and III (Figure 36) with extensive syncoxal areas, internal angle of coxa I slightly trenchant, internal spurs lacking; *coxae* IV, subtriangular, small postero-external spur; *hairs* slender, white, prominent broad flange-like saliences on trochanters II and III reduced salience on trochanter I. *Tarsi* (Figures 38A, 38B) relatively long and thin with numerous hairs of moderate length.

Measurements of tarsi and metatarsi of 10 females (in mm.)

	Holotype female	Average	Smallest	Largest
Length of tarsus I	0.62	0.59	0.55	0.62
Length of metatarsus I	0.31	0.30	0.29	0.32
Length of tarsus IV	0.53	0.53	0.51	0.55
Length of metatarsus IV	0.35	0.34	0.33	0.37

SPIRACULAR PLATE. Oval, long axis transverse to that of body, macula slightly ventrally placed, dimensions, holotype female, 0.23 mm. x 0.18 mm., average size based on 10 females, 0.23 mm. x 0.19 mm., smallest, 0.20 m. x 0.17 mm., largest, 0.24 mm x 0.21 mm.

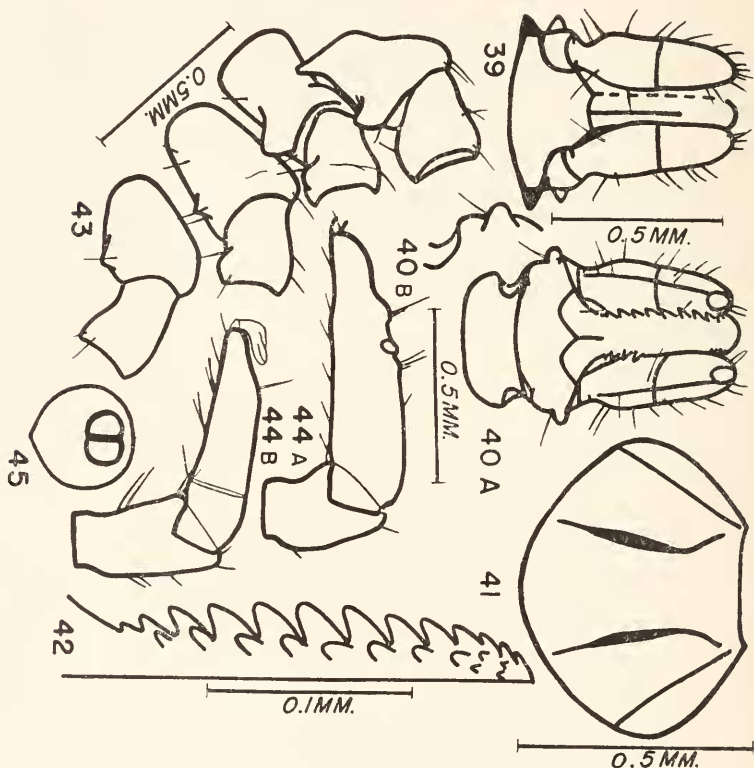
ANAL GROOVES (Figure 37). Circular, closed, ending in a slight point behind.

GENITAL ORIFICE. Level with posterior margin of *coxae* IV, small, crescentic, unlobed genital apron.

Description. NYMPH. *Body* broadly rounded posteriorly, narrowing anteriorly, greatest width just behind level of *coxae* IV; in alcohol preserved nymphs alloscutum pale cream, with curved white hairs of moderate length, legs, pale brown: anterior half of scutum and palps more heavily pigmented but less so than basis capituli, scutum reaches back to about one-third of opisthosomatic length in unfed or partially gorged specimens.

CAPITULUM (Figures 39, 40A, 40B). *Basis capituli* twice as broad as long, yellow-brown centrally, reddish-brown peripherally, dorsal ridge gently convex and extended to lateral points, cornua lacking, antero-lateral margins sharply convergent to palpal base; surface of basis reticulately patterned and elevated near dorsal ridge, gently sloping ventro-laterally, but becoming steeper along the antero-lateral margins. *Palpi* relatively short, article 2 (0.12-0.13-0.15 mm.) slightly longer than article 3 (0.095-0.11-0.12 mm.); tapering distinctly along length of article

3, lateral profile strongly constricted basally, thence almost straight to the suture between articles 2 and 3, greatest breadth about mid-length of article 2, article 3 rounded apically; mesially article 1 has a small dorsally directed flange-like projection, *hairs* long on lateral profile and basally on article 2, fewer in number mesially, tuft of smaller hairs apically. Ventrally *basis capituli* has straight posterior border, postero-lateral angles rounded converging to well defined "waist," auriculae consist of bilobed flat-



Figs. 39-45. *Ixodes muniensis*, nymph: 39. Capitulum, dorsal; 40A. Capitulum ventral; 40B. Auricula; 41. Scutum; 42. Hypostome; 43. Coxae and trochanters I-IV; 44A. Tarsus and metatarsus I; 44B. Tarsus and metatarsus IV; 45. Anal plate.

tened projections with rounded apices, directed postero-laterally, with the more posterior lobe ventrally inclined; a prominent postero-laterally directed hair between the lobes, auriculae connected by strong curved transverse ridge, becoming less elevated in mid-line; surface reticulately patterned, yellowish-brown centrally, deeper reddish-brown peripherally. Surface convex behind the ridge but flat in front, pair of moderate length hairs posterior and lateral to hypostomal base. Mesial surfaces of both palpal articles 2 and 3 flat. *Hypostome*. Length of hypostome figured (Figure 42), 0.26 mm.; mean length, 0.24 mm., shortest, 0.22 mm., longest, 0.26 mm., greatest width about mid-length, tapering to rounded apex, denticles broad, blunt, arranged in 8 rows of 2/2, 2 rows of 3/3.

Measurements of 15 nymphs (in mm.)

	Average	Smallest	Largest
Length of capitulum from dorsal ridge	0.13	0.12	0.15
Breadth along dorsal ridge	0.29	0.26	0.31
Breadth across auriculae	0.29	0.25	0.34

SCUTUM. Length, 0.47 - 0.53 - 0.57 mm., breadth, 0.55 - 0.60 - 0.63 mm., colour pale to medium brown; transversely ovate, antero-lateral margins converge to scapulae in slight convexity with minor undulations, postero-lateral margins behind greatest breadth converge more strongly to broadly rounded posterior margin; *lateral carinae* as slight straight elevations fading into general elevation of scutum anteriorly and widening postero-laterally, lateral field slopes gently peripherally; *cervical grooves* shallow, widest about mid-length, fading posteriorly and not attaining postero-lateral margins, divergent in front: scapulae minute, broad, blunt, emargination weak. *Punctations* few in number, small and shallow of equal size, most abundant posteriorly; few short white adpressed hairs, most dense on lateral fields.

LEGS. Moderate size, *coxa* I (Figure 43) with moderate sized pyramidal pointed external spur and longer conical pointed internal spur, coxae II, III and IV with successively decreasing pyramidal, pointed spurs, few hairs of varying lengths on each

coxa, small flange-like saliences on trochanters I-III. *Tarsi* (Figures 44A, 44B) relatively short, broad, with slight hump distal to Haller's organ on tarsus I; length of tarsus I, 0.37 - 0.41 - 0.44 mm., metatarsus I, 0.17 - 0.18 - 0.19 mm.; tarsus IV, 0.29 - 0.34 - 0.36 mm., metatarsus IV, 0.18 - 0.22 - 0.23 mm.

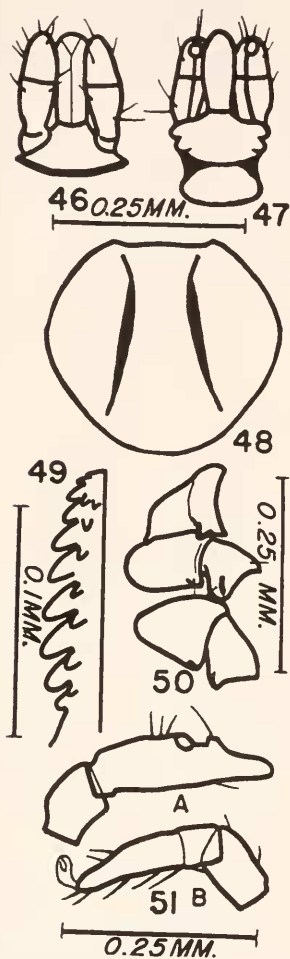
SPIRACULAR PLATE. Oval, longitudinal axis transverse to that of body, macula ventral and slightly anterior of center, dimensions: average 0.16 mm. x 0.14 mm., smallest 0.12 mm. x 0.11 mm., largest 0.17 mm. x 0.17 mm.

ANAL GROOVES. Oval, long axis parallel to that of body, closed, circular terminating in a slight point behind (Figure 45).

Description. **LARVA.** Fully fed larvae almost elliptical in shape, in alcohol preserved specimens alloscutum black, few scattered short, curved white hairs, legs and palpi pale brown, basis capituli medium brown, scutum yellow or dark brown with yellowish margins, scutum reaches back to less than a quarter of opisthosomatic length in fully fed specimens, greatest width about mid-length, anal grooves closed, circular.

CAPITULUM. Total length of capitulum, 0.19 mm., breadth across dorsal ridge, 0.15 mm. *Basis capituli* twice as long as broad (Figures 46, 47) dorsal ridge convex, drawn out to lateral points, no cornua; lateral margins short, strongly convergent to palpal bases; surface of basis capituli reticulately patterned, elevated into two prominent mounds mesial of palpal bases, depressed in mid-line behind hypostome, gentle slope antero-laterally, becoming steeper along rostral margins: *Palpi* short, article 2 (0.065 mm.) a little longer than article 3 (0.058 mm.), lateral profile of article 2 indented basally, thence gently convex to apex, mesially article 2 almost straight and article 3 terminates in a fairly acute rounded apex, long hairs present laterally, fewer mesially; mesial surface of articles 2 and 3 flat. Ventral view (Figure 47) posterior margin of venter of *basis capituli* slightly curved, posterolateral angles gently rounded, constricted laterally; auriculae as in nymph, each lobe flattened ventrally, subtriangular with blunt apices, directed more or less laterally, breadth across auriculae, 0.13 mm., strong curved transverse ridge, auriculae elevated above posterior extension of *basis capituli*: surface reticulately patterned; anterior to transverse ridge, pale brown, behind ridge more heavily pigmented. *Hypostome* (Figure 49) short, approximately parallel-sided,

rounded apex with broad "corona," succeeded by 1 row of 3/3, 6 rows 2/2, 1 row 1/1; length 0.13 mm.



Figs. 46-51B. *Ixodes muniensis*, larva; 46. Capitulum, dorsal; 47. Capitulum, ventral; 48. Scutum; 49. Hypostome; 50. Coxae I-III and trochanters II-III; 51A. Tarsus and metatarsus I; 51B. Tarsus and metatarsus III.

SCUTUM. Colour variable in alcohol preserved specimens, e.g., black, yellow, black with yellow margins—black with paler coloration anteriorly: about as broad as long, length 0.29 mm., breadth 0.29 mm., greatest breadth at about mid-length, antero-lateral margins curve gradually to almost negligible scapulae, lateral margins rounded, *lateral carinae* very slight elevations close to antero-lateral margins; *cervical grooves* shallow, widest about midway along, narrowing appreciably behind and not reaching postero-lateral margins. *Punctations* very few, equal, indistinct, small and shallow, confined to posterior and lateral portions of scutum; specimens examined glabrous.

LEGS. Moderate length and thickness, *coxa I* (Figure 50) with pointed, horn-like external spur, smaller conical internal spur, few long hairs on coxae; small flange-like saliences on trochanters I and III, largest on II. *Tarsi* (Figures 51A, B) with several long hairs, tarsus I broad, humped, length of tarsus I, 0.22 mm., length of metatarsus I, 0.1 mm.; length of tarsus III, 0.20 mm., length of metatarsus III, 0.1 mm.

ANAL APERTURE. Fairly near posterior border; anal grooves closed, circular.

Related species. *I. muniensis*, like *I. rarus* and *I. pseudorarus*, is not a host specific tick and appears from the limited data available to be a West African species. This new species is readily recognizable from other species of the *rarus* group by the characters which appear in the key (p. 535). Males are unknown.

Hosts. *Cephalophus*, duiker, tabby cat, forest antelope, *Neotragus pygmaeus*, *Felis pardus*.

IXODES PROCAVIAE new species

(Figures 52-72)

Holotype. Female, from *Dendrohyrax adolfifriederici*, Kisenyi, Belgian Congo, 6 September, 1949. Deposited in the Rocky Mountain Laboratory, Hamilton, Montana, U. S. A. Number (25) 27839.

Allotype. Male, no host or locality data, Rocky Mountain Laboratory, Hamilton, Montana, U. S. A. Number 26006.

Paratypes. 2 females, 1 male, 1 nymph. Data as for allotype

and all deposited in the Rocky Mountain Laboratory, Hamilton, Montana, U. S. A.

OTHER MATERIAL EXAMINED. Total, 15 females, 2 males, 1 nymph. 3 females, *Procavia adolfifriederici* Brauer, Burunga, Belgian Congo, H. Schouteden *leg.* (MC); 5 females, *Procavia*?, Burunga, Kini, -12.1925, H. Schouteden *leg.* (MC 8178-8182); 1 female, *Phacochoerus* sp., Bururi, 1.6.1949, J. Francois *leg.* (MC 68842); 1 female, *Dendrohyrax arboreus*, Kisenyi, Ruanda, J. Deom *leg.* (MC 72375); 2 females, Rift Valley Province, Kenya (HH collection).

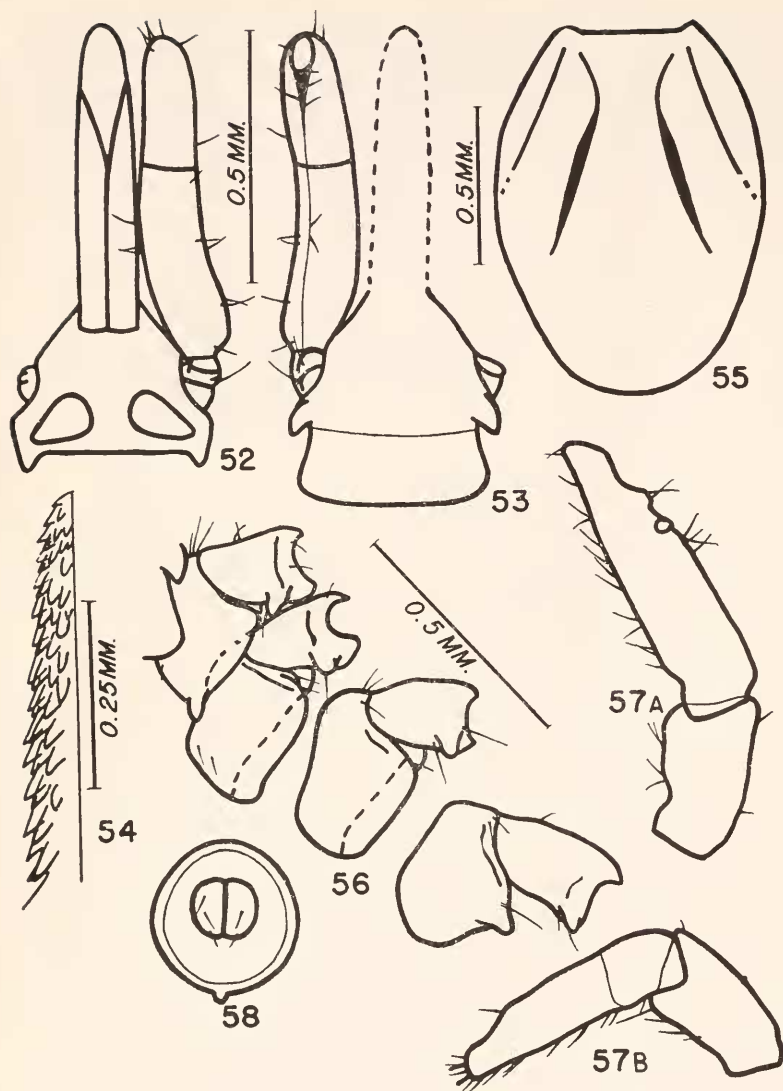
Description. FEMALE. Elongate oval, tapering more strongly anteriorly, maximum width just in front of spiracle; anal aperture situated far back, scutum reaches back beyond half opisthosomatic length. Alloscutum dark grey in alcohol preserved specimens, with white hairs closely applied to the body.

CAPITULUM. *Basis capituli* average length from dorsal ridge to rostral base 0.30 mm. (holotype 0.26 mm., range 0.26-0.32 mm.), average breadth across dorsal ridge, 0.37 mm. (holotype 0.37 mm., range 0.34 - 0.39 mm.); dorsal ridge straight between cornua, latter well-developed, relatively slender, subtriangular with blunt salient apices; lateral margins carinate, slightly diverging anteriorly to level of palpal insertion; surface reticulately patterned, flat except for pronounced lateroventral curvature in the rostral region. *Porose areas* distinct, of moderate extent, piriform, moderately depressed, separated by an interval about equal to their maximum breadth (Figure 52). *Palpi*, long, slender about five times as long as the greatest width; apex broadly rounded with more acute curvature mesially; mean length of article 2, 0.40 mm. (holotype, 0.42 mm., range 0.39 mm. -0.42 mm.); article 3, 0.25 mm., (holotype, 0.26 mm., range 0.23 mm. -0.26 mm.); lateral profile of article 2 strongly indented baso-laterally, thereafter distinctly concave to the suture line between articles 2 and 3, article 3 with straight or slightly convex lateral outline; mesial profile of article 2 convex, that of 3 almost straight; article 1 broader than long with small, pointed dorsally directed spur, situated close to meso-dorsal margin; bristles few, moderate to long. *Basis capituli* more heavily pigmented ventrally than dorsally, posterior border straight with prominent, rounded postero-lateral extensions (Figure 53), lateral margins slightly constricted behind auriculae, latter short,

flattened backwardly-directed horns narrowing to their tips and directed postero-ventrally; palpal article 1 possessing a saddle-shaped spur adjacent to antero-lateral margin of *basis capituli*, two fine white hairs arise dorsal to this spur; mesial surface of article 2 flattened, that of 3 slightly indented. *Hypostome* (Figure 54), average length 0.59 mm., (holotype, 0.60 mm., range 0.57 mm. -0.60 mm.), tapering slightly from base to apex which is domed, denticles long, slender becoming slightly shorter towards the mid-line, dentition from base to apex as 2 rows of 2/2 files, 3 rows of 3/3 files,, 3 rows of 4/4 files, 6 rows of 5/5 files surmounted by a small "corona."

SCUTUM. Colour brown, elongate oval in shape with greatest width in front of mid-length, average length, 1.24 mm., (holotype, 1.25 mm., range 1.18 — 1.27 mm.), average breadth, 0.86 mm., (holotype, 0.88 mm., range 0.80 — 0.89 mm.). Antero-lateral margins converge to broad, blunt, short scapulae (Figure 55) by a few minor undulations, behind greatest width convergent margins either rectilinear or slightly concave and terminate in broadly rounded posterior extremity. *Lateral carinae* as slight, straight elevations which are most pronounced about three quarters of their length posteriorly, lateral field slopes strongly from the carinae. *Cervical grooves* strongly convergent posteriorly before becoming divergent for the greater part of their length, shallow and narrow at first subsequently broadening, do not attain postero-lateral borders. *Punctations* small to medium-sized, distantly spaced and more numerous posteriorly than anteriorly. *Hairs* few, irregularly dispersed but most frequent anteriorly between the cervical grooves.

LEGS. Long. *Coxae* I, II and III with small syncoxal areas (cf. *Ixodes muniensis*), trenchant behind, prominent sharp postero-internal spur on coxa I which may or may not reach to or slightly overlap the anterior margin of II, postero-internal angle of II forms a marginal salience, long tapering external spur on coxa IV; coxae each supplied with a variable number of long white hairs. Each trochanter supplied with long, sharp spurs (longer than indicated in Figure 56). *Tarsi* with dorsal surface converging slightly to Haller's organ (Figure 57A), and followed



Figs. 52-58. *Ixodes procaviae*, female: 52. Capitulum, dorsal; 53. Capitulum, ventral; 54. Hypostome; 55. Scutum; 56. Coxae and trochanters I-IV; 57A. Tarsus and metatarsus I; 57B. Tarsus and metatarsus IV; 58. Anal plate.

by a moderate sub-apical hump, the latter is less well defined on tarsi II-IV, hairs becoming stronger and shorter from tarsi I to IV; average length of tarsus I, 0.61 mm. (holotype, 0.62 mm., range 0.57 mm. — 0.63 mm.), metatarsus I, 0.32 mm. (holotype, 0.32 mm., range 0.31 mm. — 0.32 mm.); tarsus IV, 0.51 mm., (missing in holotype, range 0.49 mm. — 0.52 mm.); metatarsus IV, 0.34 mm. (missing in holotype, range 0.33 m. — 0.35 mm.).

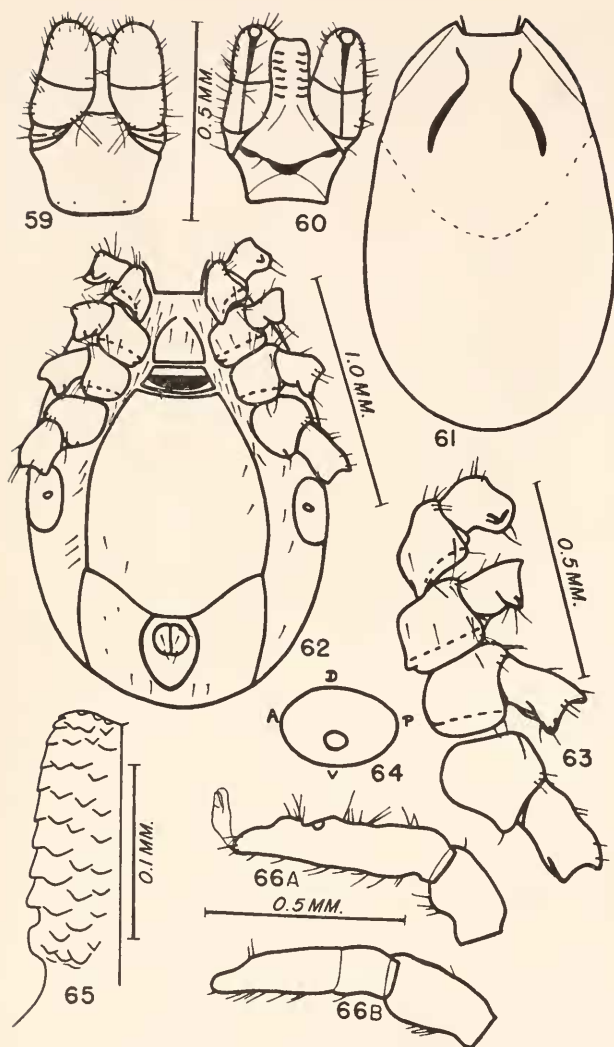
SPIRACULAR PLATE. Slightly ovate, long axis transverse to that of body, macula slightly anterior of center; dimensions, mean, 0.25 x 0.21 mm., holotype, 0.23 x 0.20 mm., range, 0.22 — 0.26 mm. x 0.19 — 0.23 mm.

ANAL GROOVE. Oval, closed and in some specimens terminates in a small point, long axis parallel with corresponding axis of body (Figure 58).

GENITAL ORIFICE. On a level with posterior margin of coxae IV; narrow, long crescentic.

Description. **MALE.** Elongate oval, but tapering quite strongly in front with a broad posterior extremity. Length from tip of palpi to posterior body margin 2.13 mm.; greatest body width at the level of the spiracles 1.25 mm., body flat. Colour of alcohol preserved specimens, medium brown alloscutum, sclerotized parts golden brown.

CAPITULUM. Overall length from dorsal ridge to palpal tips 0.49 mm., greatest breadth behind palpal insertion, 0.31 mm., breadth across dorsal ridge, 0.22 mm. *Basis capituli* (Figure 59) broader than long, mid-region golden brown, black peripherally, posterior margin straight, postero-lateral angles rounded, sides divergent to base of palps; surface irregularly sculptured, convex medianly behind cheliceral "foramen," otherwise flattened except for a slight elevation along the posterior ridge, few scattered small pores. *Palpi*, short, broad, globular, about twice as long as the greatest breadth; dorsally article 2 slightly longer than article 3 (as 0.15 mm. is to 0.14 mm.), with the greatest width at the apex of article 2; apex broadly rounded; lateral margin of article 2 swollen basally then either straight or gently concave to suture, profile of article 3 straight, mesial margin of articles 2 and 3 broadly convex; *hairs* of moderate length, fine particularly laterally, two long strong hairs arise mesodorsally and basally from article 2. Ventrally (Figure 60) basal margin either straight or faintly concave, lateral margins concave, di-



Figs. 59-66B. *Ixodes procaviae*, male: 59. Capitulum, dorsal; 60. Capitulum, ventral; 61. Scutum; 62. Venter; 63. Coxae and trochanters I-IV; 64. Spiracular plate; 65. Hypostome; 66A. Tarsus and metatarsus I; 66B. Tarsus and metatarsus IV.

vergent; auriculae as small, raised lips linked by a transverse ridge to form a broad, tongue-shaped eminence in the midline, gentle slope from the ridge anteriorly; steeper, sharper slope posteriorly; one pair of small white hairs—one on each side lateral to and behind the hypostomal base, second pair of hairs on ridge between the auriculae and the median tongue-shaped eminence; mesial surfaces of articles 2 and 3 slightly concave. *Hypostome* (Figure 65) short (0.22 mm.), broad, tapering, and indented apically. Dentition consists of at least 7 rows of crenulations arranged in 4/4 files.

SCUTUM. Colour, medium to dark brown. Scutal surface very slightly convex centrally, gradually downcurved laterally, long oval in shape (Figure 61) but narrowing more strongly in front than behind, length 1.69 mm., breadth 1.05 mm. *Cervical grooves* short, not extending back to the level of the faintly indicated pseudoscutum, slightly converging and thence widely divergent, shallow—narrow initially before broadening. *Punctations* numerous, shallow, small, fewer in number anteriorly. *Scapulae* short, broad sharp; emargination moderate. *Hairs* few, short, white more abundant posteriorly than anteriorly.

LEGS. Moderate length and breadth. *Coxae* I, II and III with relatively small syncoxal areas, coxa I with distinct broad tapering postero-internal spur, coxa II with short internal spur mesially and forward of the postero-internal position, coxa IV with broad-based conical external spur; coxae I and II trenchant behind. Several hairs of varying length on all coxae. *Trochanters* I, II and III with prominent conical spurs, that on IV less pronounced—these spurs are not as strong as the comparable ones in females. *Tarsi* humped, broad, with moderate to long hairs; length of tarsus I, 0.54 mm., metatarsus I, 0.25 mm.; tarsus IV, 0.46 mm., metatarsus IV, 0.30 mm. (Figures 66A, B).

SPIRACULAR PLATE. Elongate oval (Figure 64) long axis parallel to that of body, goblets numerous, macula anteroventral; dimensions 0.20 mm. x 0.28 mm.

VENTRAL PLATES. *Pregenital plate* with straight posterior edge, lateral margins curved and converging anteriorly; *median plate* large, much wider behind than in front, lateral and posterior

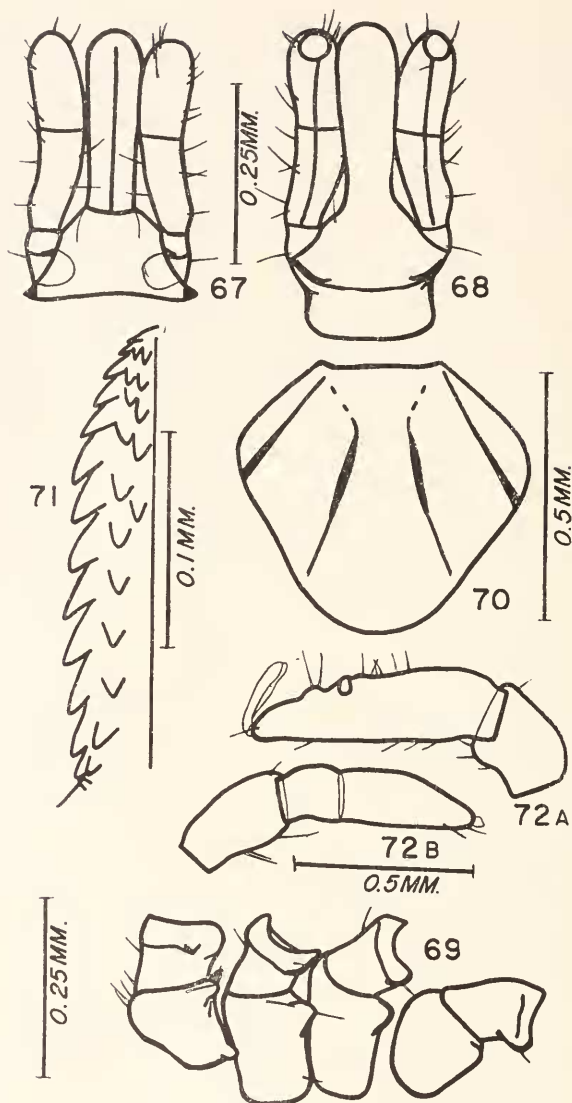
margins curved (see Figure 62); *adanal plates* almost rhomboidal, sides adjacent to anal plate incompletely concave; *anal plate* almost egg-shaped with anterior edge flattened; small transverse subrectangular plate between genital orifice and pregenital plate.

GENITAL ORIFICE. Wide, located between coxae III.

Description. NYMPH (described from a single specimen from lot RML—26006). *Body* shape as in female except that the greatest width occurs across coxae IV; has some of the salient characters of the female.

CAPITULUM. Length, 0.30 mm., breadth across auriculae 0.20 mm., breadth across dorsal ridge, 0.245 mm., *basis capituli* about twice as broad as long, dorsal ridge slightly concave, and produced to salient lateral projections, which mark the greatest width, lateral margins very short and sharply convergent to palpal insertions; surface reticulately patterned, gently convex except for a slight elevation along the dorsal ridge, and strong slope peripherally. *Palpi* long, club shaped, length of article 2, 0.16 mm., length of article 3, 0.14 mm., article 3 stouter than article 2, greatest breadth 0.05 mm. Article 2 swollen basally for a short distance thence concave to the rounded palpal apex, mesial profile of articles 2 and 3 broadly convex; article 1 with small mesodorsal spur, *hairs*, long, particularly laterally. Ventrally, posterior edge of *basis capituli* straight (Figure 68), posterolateral edges sharply rounded, sides slightly constricted; auriculae small flange-like lobes, not particularly elevated above surface, more heavily pigmented than rest of basis; pair of small hairs placed posterior and lateral to hypostomal base, one long curved white hair on each side in front of auriculae; palpal article 1 with small elongate saddle-shaped spur, mesial surface of article 2 flat, that of 3 concave. *Hypostome* length, 0.26 mm., profile curved, apex rounded, external teeth larger than internal teeth, dentition from apex to base as 5 rows of 3/3 files, 6 rows of 2/2 files (Figure 71).

SCUTUM. Colour, brown beyond cervical grooves, paler in between latter and posteriorly. Large, nearly as broad as long; length 0.54 mm., breadth 0.52 mm., greatest breadth about one-



Figs. 67-72B. *Ixodes procaviae*, nymph: 67. Capitulum, dorsal; 68. Capitulum, ventral; 69. Coxae and trochanters I-IV; 70. Scutum; 71. Hypostome; 72A. Tarsus and metatarsus I; 72B. Tarsus and metatarsus IV.

third distance from scapulae, latter short, broad, blunt; antero-lateral margins almost rectilinear, convergent to scapulae, at greatest width sharply angled (Figure 70) thence by slightly sinuous postero-lateral sides to broadly rounded posterior extremity; *lateral carinae* as minor elevations, becoming wider and losing height as lateral margins reached, short, straight; lateral field slopes gently from the ridge; *cervical grooves* convergent, indistinct and shallow anteriorly, then diverging, widening but not attaining postero-lateral margins. *Punctations* distinct, few, small, shallow, most numerous behind greatest breadth; *hairs* short, white, most prominent anteriorly and laterally.

LEGS. Of moderate length and thickness. *Coxa* I with sharp pointed, conical, internal and external spurs (Figure 69), coxae II and III with moderate-sized, round-ended, pyramidal, external spurs, coxa IV, with broad-lobed external salience; posterior margin of coxa I and postero-external angle of coxa IV trenchant. *Trochanter* spurs on all coxae, that on I being small and conical, on II-IV broad, flange-like. *Tarsi* (Figures 72A, B) taper gradually from proximal to distal end, slight pre-apical hump on I, becoming less well defined from II to IV; length of tarsus I, 0.36 mm., metatarsus I, 0.15 mm.; tarsus IV, 0.28 mm., metatarsus IV, 0.17 mm.

SPIRACULAR PLATE. 0.12 mm. x 0.10 mm., long axis transverse to that of body, macula almost centrally placed.

ANAL GROOVE. Oval, slightly open behind, longitudinal axis parallel to that of body.

LARVA. Unknown.

Related species. The females of *procaviae* and *thomasae* agree in the form of their auriculae and the spurring of coxae I and II, apart from the closed anal groove. The postero-lateral extension of the venter of the basis capituli together with the long, tapering trochanter spurs make it readily distinguishable from other members of the *rasus* complex of species.

Hosts. *Dendrohyrax adolfi-friederici*, *Dendrohyrax arboreus*, *Procavia*, *Phacochoerus* sp. (Names of hosts given here are as on data enclosed with the specimens in the tubes.)

Remarks. At present known only from the Belgian Congo, Uganda and Kenya.

IXODES THOMASAE new species

(Figures 73-79)

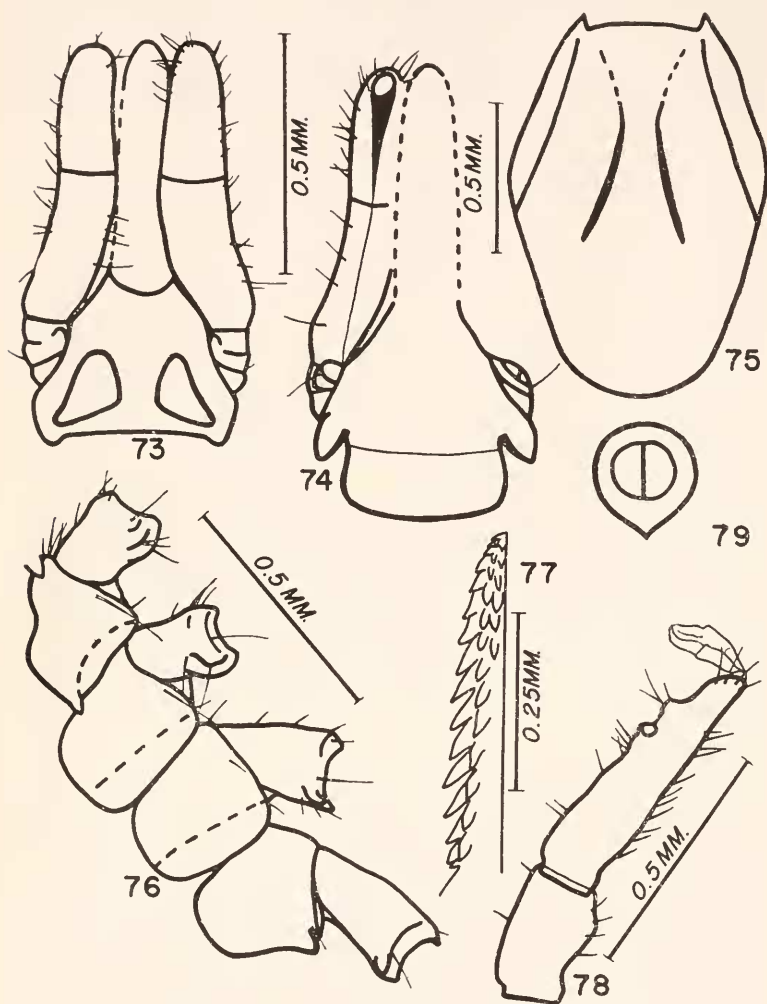
Holotype. Female, Host: HH 4093, *Arvicanthis abyssinicus nubilans*, Njoro, Rift Valley Province, Kenya, 7500 ft., 14 June, 1948, H. Hoogstraal *leg.* Deposited in Rocky Mountain Laboratory, Hamilton, Montana.

Paratype. One female, Host: HH 4106, *Otomys tropicalis elongis*, Njoro, Rift Valley Province, Kenya, 7500 ft., 15 June, 1948, H. Hoogstraal *leg.* Deposited in British Museum (Natural History).

Description. FEMALE. *Body shape* of unfed female elongate oval, narrowing anteriorly, broadly rounded posteriorly, greatest width just behind the spiracle; Colour, sclerotized parts dark brown, alloseutum reddish brown in alcohol preserved specimens, well covered with white adpressed hairs of moderate length: Anal aperture far back. Scutum extends well beyond half opisthosomatic length.

CAPITULUM. Overall length from cornua to palpal tips 0.85 mm., breadth across dorsal ridge, 0.38 mm., dorsal ridge straight between cornua, latter small, broad-based with blunt apices, lateral margins slightly convex, divergent almost to level of palpal insertion, which is the widest point (Figure 73); surface reticulately patterned depressed around and in front of the porose areas, inter-porose area and surface adjacent to the dorsal ridge elevated, strong ventral curvature near antero-lateral borders. *Porose areas* subtriangular, slightly depressed, inter-porose interval less than the maximum breadth. *Palpi* long, about five times as long as the greatest width; lateral profile distinctly concave, with mesial convexity more or less parallel to it, apex rounded; length of article 2, 0.39 mm., article 3, 0.26 mm.; article 1 with small dorsally-directed flange-like spur arising adjacent to lateral margin of basis capituli: latter nearly one and a half times as broad as long. Ventrally (Figure 74) *basis capituli* more heavily pigmented than dorsally, reddish-brown pigmentation peripherally, surface reticulately patterned, flat, except behind the auriculae and the antero-lateral margins which curve away dorsally; posterior border broadly curved, postero-lateral edges sharply rounded, lateral margins gently and slightly constricted; greatest breadth (0.45 mm.) across auriculae, latter

well developed, tapering horn-like spurs which are flattened on their ventral surfaces, horizontal and directed postero-laterally;



Figs. 73-79. *Ixodes thomassae*, female; 73. Capitulum, dorsal; 74. Capitulum, ventral; 75. Scutum; 76. Coxae and trochanters I-IV; 77. Hypostome; 78. Tarsus and metatarsus I. 79. Anal groove.

pair of hairs posterior and lateral to hypostomal base; palpal article I with saddle-shaped spur from which a long white hair projects postero-laterally, mesial surface of article 2 flat, that of 3 slightly concave. *Hypostome* (Figure 77) long (0.57 mm.), narrow, tapering to a pointed apex, outer file of denticles larger than those nearer the mid-line and arranged from base to apex as 1 row of 1/1 files, 7 rows of 2/2 files, 6 rows of 3/3 files, surmounted by a small corona.

SCUTUM. Colour, brown; large, rhomboidal, longer than broad (1.32 mm. x 0.88 mm.) with greatest breadth in front of mid-length; antero-lateral margins faintly undulate and convergent to scapulae, postero-lateral margins straight, converging to posterior convexity. *Lateral carinae* distinct, broadening postero-laterally and reaching the margins just behind greatest width, lateral field beyond carinae sloping strongly. *Cervical grooves* weak anteriorly but on diverging become deeper and wider depressions about mid-length, do not extend to the periphery. *Punctations* medium size, moderate depth and uniformly distributed. Glabrous in holotype.

LEGS. Small to moderate syncoxae on *coxae* I-III (Figure 76), short conical internal spur on coxa I, large external spur on coxa IV, all *coxae* trenchant; few hairs of varying sizes on all *coxae*. *Trochanters* I-III bear well developed broad rounded saliences, that on IV reduced to a smaller spur. *Tarsi* long, tapering with a distinct hump beyond Haller's organ (Figure 78).

SPIRACULAR PLATE. Oval, with long axis transverse to corresponding axis of body, macula antero-ventral, dimensions 0.26 x 0.22 mm.

ANAL GROOVE. Circular and drawn out to a small point posteriorly, closed (Figure 79).

GENITAL ORIFICE. Between *coxae* IV, genital apron large, oval, unilobed.

This species is named for Miss Dilys G. Thomas of the Administrative Staff of King's College, London, who has exhibited the greatest patience as well as a high degree of efficiency in dealing with our continual typing requirements on acarological matters.

Related species. See the key on page 535 and the information on page 531.

Hosts. *Arvicanthis abyssinicus nubilans*, *Otomys tropicalis elgonis*.

Remarks. Known only from Kenya.

Key to the known species of African Ticks allied to IXODES RASUS Neumann by virtue of their possession of a closed anal groove.

(Characters mentioned are sufficient to serve as a diagnosis of new species described herein.)

Females

1. Auriculae as sharp retrograde spurs *Ixodes rasus*
Auriculae otherwise 2
2. Coxa I lacking internal spurs 3
Coxa I with internal spur 4
3. Cornua about as long as basal breadth, auriculae straight edged, directed postero-ventrally, coxa IV with slight external spur *I.muniensis*
Cornua shorter than basal breadth, auriculae lobed, directed laterally, coxae IV without external spur *I.pseudorasus*
4. Auriculae lobed as in *pseudorasus* Variant of *I.pseudorasus*
Auriculae tapering nearly to a point, directed postero-laterally 5
5. Posterior margin of venter of basis capituli extended laterally, trochanter spurs long, pointed. Hypostomal dentition 3/3 files for nearly the whole length *I.procaviae*
Posterior margin of venter of basis capituli not extended laterally, trochanter spurs as broad rounded saliences. Hypostomal dentition 3/3 for distal third *I.thomasa*

Males

(The males of *I.muniensis* and *I.thomasa* are not known.)

1. Coxae II with short internal spur mesial and forward of the postero-internal position, basis capituli relatively narrow *I.procaviae*
Coxa II lacking such spurs, basis capituli broad 2
2. Syncoxal areas on coxae II and III extensive, scutum with steadily convex margins, projections on transverse ridge not well developed *I.pseudorasus*
Syncoxal areas on coxae II and III not extensive, scutum with rectilinear margins, projections on transverse ridge well developed and large *I.rasus*

SUMMARY

1. The male and female of *Ixodes rarus* of Neumann (1899) are redescribed and the systematic status of the female of the species bearing this name, as described by Nuttall *et al* (1911), is critically reviewed. After examination of a large number of ticks we have arrived at the conclusion that the female of *rarus*, as described by Nuttall *et al* should be assigned specific rank as *pseudorarus*. No such great variation, as suggested by them, occurs in the specimens we have studied.
2. The subspecific forms of *I.r.cumulatimpunctatus* and *I.r.eidmanni* of Schulze (1943) have not been observed, and we consider that in certain respects his subspecific characters are inadequate for diagnostic purposes.
3. The male of *pseudorarus* is described and a variant of the female of this form noted.
4. Three other new species having closed, circular, anal grooves are described. These are *I.muniensis* (female, nymph, larva), *I.procaviac* (female, male, nymph) and *I.thomasa* (female).
5. All species appear to have a wide range of potential hosts.

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